

TABLE 1-FSS ¹

Limits to the aggregate EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands

Frequency Band (GHz)	epfd_{down} dB(W/m²)	Percentage of time during which equivalent pfd may not be exceeded	Reference Bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern ²
17.8-18.6	-164	100	40 ³	1 m Rec. S.[4/57]
	-164	99.9		
	-170	90		
	-170	0		
17.8-18.6	-164	100	40 ³	2 m Rec. S.[4/57]
	-164	99.92		
	-166	99.9		
	-173	99.4		
	-173	0		
17.8-18.6	-164	100	40 ³	5 m Rec. S.[4/57]
	-164	99.992		
	-172	99.8		
	-180	99.8		
	-180	0		

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

³ For non-GSO emission bandwidths greater than 40 kHz, the epfd_{down} limits may be scaled by adding 10 log(non-GSO emission bandwidth / 40 kHz) in a reference bandwidth equal to the emission bandwidth.

TABLE 1-FSS¹

Limits to the aggregate EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands

Frequency Band (GHz)	epfd_{down} dB(W/m²)	Percentage of time during which equivalent pfd may not be exceeded	Reference Bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern²
19.7-20.2	-154 -154 -172 -182	100 99.94 90 0	40 ³	70 cm Rec. S.[4/57]
19.7-20.2	-154 -154 -160 -165 -176 -185	100 99.99 99.8 99.8 91 0	40 ³	90 cm Rec. S.[4/57]
19.7-20.2	-154.35 -154.35 -191	100 99.99 0	40 ³	2.5 m Rec. S.[4/57] see note 4
19.7-20.2	-154.35 -154.35 -175 -184 -195	100 99.996 99.6 90 0	40 ³	5 m Rec. S.[4/57] see note 4

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

³ For non-GSO emission bandwidths greater than 40kHz, the epfd_{down} limits may be scaled by adding $10 \log(\text{non-GSO emission bandwidth} / 40 \text{ kHz})$ in a reference bandwidth equal to the emission bandwidth.

⁴ The masks for the 2.5m and 5m antennas have not been agreed. Further adjustments to these masks are required.

TABLE 1-BSS ¹

Limits to the aggregate EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands

30cm, 45cm, and 60cm BSS antennas

Frequency band (GHz)	Equivalent pfd dB(W/m²)	Percentage of time during which equivalent pfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern ²
11.7 – 12.5 GHz In Region 1	-160.400 -160.100 -158.600	0.000 25.000 96.000	40	30 cm DNR ITU-R BO.[Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-158.600	98.000		
12.5 – 12.75 GHz In Region 3	-158.330	98.000		
12.2 – 12.7 GHz In Region 2	-158.330	100.000		
11.7 – 12.5 GHz In Region 1	-170.000 -167.000 -164.000	0.000 66.000 97.750	40	45 cm DNR ITU-R BO.[Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-160.750	99.330		
12.5 – 12.75 GHz In Region 3	-160.750 -160.000	99.330 99.950		
12.2 – 12.7 GHz In Region 2	-159.900	100.000		
11.7 – 12.5 GHz In Region 1	-171.000 -168.750 -167.750	0.000 90.000 97.800	40	60 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-162.000	99.600		
12.5 – 12.75 GHz In Region 3	-161.000 -160.200	99.800 99.900		
12.2 – 12.7 GHz In Region 2	-160.000 -159.900	99.990 100.000		

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

TABLE 1-BSS¹

Limits to the aggregate EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands

90cm and 120cm BSS antennas

Frequency band (GHz)	Equivalent pfd dB(W/m²)	Percentage of time during which equivalent pfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern²
11.7 – 12.5 GHz In Region 1	-173.75 -173 -171	0.000 33.000 98.000	40	90 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-165.5	99.100		
12.5 – 12.75 GHz In Region 3	-163 -161	99.500 99.800		
12.2 – 12.7 GHz In Region 2	-160 -159.9	99.970 100.000		
11.7 – 12.5 GHz In Region 1	-177.000 -175.250 -173.750 -173.000	0.000 90.000 98.900 98.900		
11.7 – 12.2 GHz and	-169.500	99.500		
12.5 – 12.75 GHz In Region 3	-167.800 -164.000	99.700 99.820	40	120 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
12.2 – 12.7 GHz In Region 2	-161.900 -161.000 -160.400 -159.900	99.900 99.965 99.993 100		

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

TABLE 1-BSS ¹

Limits to the aggregate EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands

180cm(*), 240cm(*) and 300cm(*) BSS antennas

Frequency band (GHz)	Equivalent pfd dB(W/m ²)	Percentage of time during which equivalent pfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern ²
11.7 – 12.5 GHz In Region 1	-179.500 -178.660 -176.250	0.000 33.000 98.500	40	180 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-163.250	99.810		
12.5 – 12.75 GHz In Region 3	-161.500 -160.350	99.910 99.975		
12.2 – 12.7 GHz	-160.000	99.995		
In Region 2	-159.900	100.000		
11.7 – 12.5 GHz In Region 1	-182.000 -180.900 -178.000	0.000 33.000 99.250	40	240 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-164.400	99.850		
12.5 – 12.75 GHz In Region 3	-161.900 -160.500	99.940 99.980		
12.2 – 12.7 GHz	-160.000	99.995		
In Region 2	-159.900	100.000		
11.7 – 12.5 GHz In Region 1	-186.500 -184.000 -180.500	0.000 33.000 99.500	40	300 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-173.000	99.700		
12.5 – 12.75 GHz In Region 3	-167.000 -162.000	99.830 99.940		
12.2 – 12.7 GHz	-160.000	99.970		
In Region 2	-159.900	100.000		

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

(*) Not agreed (see Section 3.1.3.1.4(b)). Although for antenna diameters 180 cm, 240 cm and 300 cm agreement has not been reached provisional masks have been presented. Some administrations wish to perform further studies of these masks. Further results may be available to the CPM.

ANNEX 3 TO CHAPTER 3

Example of Possible Modifications for Coordination between Non-GSO FSS Transmitting Space Stations and GSO Receive Earth Stations with Very Large Antennas

This annex contains example of regulatory and procedural text for coordination between non-GSO FSS transmitting space stations and GSO receive earth stations with very large antennas, including additions and/or modifications to Articles S9 and S22 and Appendices S4 and S5.

ARTICLE S9

Sub-Section IIA - Requirement and request for coordination

- ADD S9.7A** a1)^{11, 12} for a specific earth station within a geostationary-satellite network in the fixed-satellite service in certain frequency bands in respect of a non-geostationary satellite system in the fixed-satellite service;
- ADD S9.7B** a2)^{11, 12} for a non-geostationary-satellite system in the fixed-satellite service in certain frequency bands in respect of a specific earth station within a geostationary satellite network in the fixed-satellite service;
- MOD** ¹¹ **S9.6.2** In all cases, the coordination of an earth station with terrestrial stations, non-geostationary satellite systems, or other earth stations operating in the opposite direction of transmission shall remain within the authority of the administration on the territory of which this station is located.
- MOD** ¹² **S9.7.A and S9.7.B** Coordination information relating to a specific earth station received by the Bureau prior to [date TBD] is considered as complete **S9.7A** and **S9.7B** information from the date of receipt of complete information of the associated satellite network under S9.7 provided that the characteristics of the specific earth stations are within the parameters of any typical earth station included in the GSO FSS network coordination request..
- MOD S9.8.1 and S9.9.1** ¹³ Application of this provision with respect to Articles 6 and 7 of Appendices **S30** and **S30A** is suspended pending a decision of WRC-99 on the revision of these two Appendices.

Reasons: GSO FSS earth stations with very large antennas may not be adequately protected by the EPFD_{down} limits contained in Table MOD S22-1 and case-by-case coordination of systems operating co-frequency, co-directional links in the space-to-Earth direction would then be required. The proposed ADD S9.7A and ADD S9.7B would require coordination between non-GSO FSS transmit satellites and GSO FSS receive earth stations with very large antennas. By referring to coordination provisions under S9.7A and S9.7B, the request for coordination would be sent by the requesting administration to the Bureau under S9.30. The Bureau would act under S9.34 to identify administrations with which coordination may need to be effected and publish the information in the Weekly Circular. Since coordination between a non-GSO FSS space station and very large GSO FSS earth stations is a new type of coordination that does not currently exist in Article S9, it is necessary to add two new entry points in Article S9:

- One entry point to enable the non-GSO space station administration to request coordination with administrations having specific very large earth station antennas located on their territory.
- Another entry point to enable the reciprocal coordination to take place, i.e. the possibility for an administration planning to implement a specific very large GSO earth station stations located on their territory to request coordination with administrations having non-GSO FSS transmit space.

TABLE S22-1 (MOD)¹

TABLE S22-4 (MOD)¹

ADD ¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

Reasons: Case-by-case coordination is required by the proposed modifications in ADD S9.7A and S9.7B.

MOD TO APPENDIX S4

ANNEX 2B (TO APPENDIX S4)

Table of characteristics to be submitted for space and radio astronomy services

The required characteristics for coordinating specific very large GSO earth stations with non-GSO FSS transmit space stations could be items for "Notification or coordination of a GSO network (including Appendix S30B)" or "Notification or coordination of an earth station."

(The modifications in either column two or column three need to be incorporated into the full table.)

C – Characteristics to be provided for each group of frequency assignments for a satellite antenna beam or an earth station antenna

MOD

Items in Appendix	Notification or coordination of a GSO network (including Appendix S30B)	Notification or coordination of an earth station
C.1		
C.2.a	X	X
C.2.b		
C.3.a	X	X
C.3.b		
C.4	X	X
C.5.a	X	
C.5.b		
C.5.c		
C.6	X	X
C.7.a	X ²²	X ²²
C.7.b	C ²²	C ²²
C.7.c	C ²²	C ²²
C.7.d	C	C
C.8.a	X ⁷	C ⁸
C.8.b	X ⁷	X ⁷
C.8.c	X ⁶	X ⁶
C.8.d	X ²	
C.8.e	X ⁶	X ⁶
C.8.f		
C.8.g	C ⁴	C ^{4,5}
C.8.h		
C.8.i		
C.8.j		
C.9.a	C	
C.9.b		
C.9.c		
C.10.a	X ²²	C ²²
C.10.b	X ²²	C ²²
C.10.c.1	X ²²	C ²²
C.10.c.2	X ²²	C ²²
C.10.c.3	X	
C.10.c.4	X	
C.10.c.5	X ²²	C ²²
C.10.c.6		
C.11.a	X	
C.11.b		

C.11.c		
C.11.d		
C.12		
C.13		
C.14		

X Mandatory information.

O Optional information.

C This information need only be furnished when it has been used as a basis to effect coordination with another administration.

ZZ Information mandatory for coordination under No. **ADD S9.7A**.

Reasons: This is consequential to **ADD S9.7A** and **ADD S9.7B**. Administrations will need to submit specific earth station information for earth stations associated with geostationary-satellite networks in the fixed-satellite service meeting the conditions in the proposed addition to Appendix S5.

ADD

APPENDIX S5
TABLE S5-1 (continued)

Reference of Article S9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. S9.7A GSO earth station/ non-GSO system	A specific earth station in a geostationary satellite network in the fixed-satellite service in respect of a non-geostationary-satellite system in the fixed-satellite service.	The following frequency bands: 10.7 - 11.7 GHz (space-to-Earth), 11.7 - 12.2 GHz (space-to-Earth) in Region 2, 12.2 - 12.75 GHz (space-to-Earth) in Region 3, 12.5 - 12.75 GHz (space-to-Earth) in Region 1, 17.8 - 18.6 GHz (space-to-Earth), and 19.7 - 20.2 GHz (space-to-Earth)	Conditions: i) the frequency bands overlap and ii) the satellite network using the geostationary-satellite orbit has specific receive earth stations and meets all of the following conditions: a) Earth station antenna maximum isotropic gain greater than or equal to 64 dBi for the frequency bands 10.7 - 12.75 GHz or 68 dBi for the frequency bands 17.8 - 18.6 GHz and 19.7 - 20.2 GHz; b) G/T_1 of 44 or higher; c) space station emission bandwidth of 250 MHz or higher for the frequency bands 10.7 - 12.75 GHz or 800 MHz or higher for the frequency bands 17.8 - 18.6 GHz and 19.7 - 20.2 GHz; d) $EPFD_{down}$ exceeds [x].	i) compare frequency bands, ii) use the maximum antenna gain of the specific receive earth station (Appendix S4 C.10.c.2), the lowest equivalent satellite link noise temperature (Appendix S4 C.10.c.5), and the space station emission bandwidth (Appendix S4 C.7.a) in the geostationary-satellite network as given in Appendix S4 data; and iii) use the $EPFD_{down}$ radiated by the non-GSO FSS system into the earth station employing the very large antenna when this antenna is pointed toward the wanted GSO satellite	The thresholds/conditions for coordination do not apply to typical receive earth stations operating in satellite networks using the geostationary-satellite orbit.

<p>No. S9.7B non-GSO system/ GSO earth station/</p>	<p>A non-geostationary-satellite system in the fixed-satellite service in respect of a specific earth station in a geostationary satellite network in the fixed satellite service.</p>	<p>The following frequency bands: 10.7 - 11.7 GHz (space-to-Earth), 11.7 - 12.2 GHz (space-to-Earth) in Region 2, 12.2 - 12.75 GHz (space-to-Earth) in Region 3, 12.5 - 12.75 GHz (space-to-Earth) in Region 1, 17.8 - 18.6 GHz (space-to-Earth), and 19.7 - 20.2 GHz (space-to-Earth)</p>	<p>Conditions: i) the frequency bands overlap and ii) the satellite network using the geostationary-satellite orbit has specific receive earth stations and meets all of the following conditions: a) Earth station antenna maximum isotropic gain greater than or equal to 64 dBi for the frequency bands 10.7 - 12.75 GHz or 68 dBi for the frequency bands 17.8 - 18.6 GHz and 19.7 - 20.2 GHz b) G/T_1 of 44 or higher; c) Space station emission bandwidth of 250 MHz or higher for the frequency bands 10.7 - 12.75 GHz or 800 MHz or higher for the frequency bands 17.8 - 18.6 GHz and 19.7 - 20.2 GHz. d) $EPFD_{down}$ exceeds [x].</p>	<p>i) compare frequency bands, ii) use the maximum antenna gain of the specific receive earth station (Appendix S4 C.10.c.2), the lowest equivalent satellite link noise temperature (Appendix S4 C.10.c.5), and the space station emission bandwidth (Appendix S4 C.7.a) in the geostationary-satellite network as given in Appendix S4 data, and iii) use the $EPFD_{down}$ radiated by the non-GSO FSS system into the earth station employing the very large antenna when this antenna is pointed toward the wanted GSO satellite.</p>	<p>The threshold/condition for coordination do not apply to typical receive earth stations operating in satellite networks using the geostationary-satellite orbit.</p>
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Reasons: This is consequential to **ADD S9.7A** and **ADD S9.7B**.

ANNEX 4 TO CHAPTER 3

Examples of modifications to TABLE S21-4 (*continued*)

Frequency band	Service*	Limit in dB(W/m ²) for angle of arrival (δ) above the horizontal plane			Reference bandwidth
		0°-5°	5°-25°	25°-90°	
10.7-11.7 GHz	Fixed-satellite (space-to-Earth), geostationary-satellite orbit	-150	-150 + 0.5 ($\delta - 5$)	-140	4 kHz
10.7-11.7 GHz	Fixed-satellite (space-to-Earth), non-geostationary-satellite orbit	-126	-126 + 0.5($\delta - 5$)	-116	1 MHz
11.7-12.5 GHz (Regions 1 and 3) 12.5-12.75 GHz (Region 1 and Region 3 countries listed in Nos. S5.494 and S5.496) 11.7-12.7 GHz (Region 2)	Fixed-satellite (space-to-Earth), non-geostationary-satellite orbit	-124	-124 + 0.5 ($\delta - 5$)	-114	1 MHz
12.2-12.5 GHz ⁷ (Region 3) 12.5-12.75 GHz ⁷ (Region 1 and Region 3 countries listed in Nos. S5.494 and S5.496)	Fixed-satellite (space-to-Earth), geostationary-satellite orbit	-148	-148 + 0.5 ($\delta - 5$)	-138	4 kHz
17.7-19.3 GHz ^{7,8}	Fixed-satellite (space-to-Earth) Meteorological-satellite (space-to-Earth)	-115 ^{aa} or 115 - X ¹²	-115 + 0.5($\delta - 5$) ^{aa} or 115 - X + ((10 + X)/20) ($\delta - 5$) ¹²	-105 ^{aa} or -105 ¹²	1 MHz

ADD^{aa}**S21.16.6bis**

These limits apply to emissions of space stations on meteorological-satellites and on geostationary FSS satellites. These limits also apply to emissions of space stations on non-geostationary FSS satellites in the bands 18.8-19.3 GHz for which complete coordination or notification information has been received by the Radiocommunication Bureau by 17 November 1995, or are in operation by that date (WRC-00).

Reason: the above regulatory text reflects the date-specific provisions currently in Resolution 131.

MOD¹²**S21.16.6**

These limits apply to emissions of space stations on non-geostationary FSS satellites except those covered by S21.16.6bis. The function X is defined as a function of the number, N, of satellites in the non-GSO FSS constellation as follows:

- for $N \leq 50$ $X = 0$ (dB)
- for $50 < N \leq 288$ $X = \frac{5}{119}(N - 50)$ (dB)
- for $N > 288$ $X = \frac{1}{69}(N + 402)$ (dB) (WRC-00)

SUP¹⁴ S21.16.8

Although these limits apply to both geostationary and non-geostationary satellites in the fixed-satellite service, values for non-geostationary-satellite systems require further study (see Resolution 131 (WRC-97)).

SUP¹⁵ S21.16.9

These values require further study (see Resolution 131 (WRC-97)).

SUP

Resolution 131 (WRC-97).

3.1.5 Identification and validation of software which could be used by the BR to check whether a system for which application for spectrum has been made would comply with the APFD and EPFD limits

The equivalent power flux-density (EPFD) limits apply to the sum of all emissions from the space stations (for $EPFD_{down}$ or $EPFD_{is}$) and earth stations (for $EPFD_{up}$) of a non-geostationary orbit (non-GSO) satellite system. Furthermore, the limits are specified for various percentages of time and as a function of GSO antenna characteristics. This complex combination precludes the use of a formula to determine compliance with the limits. Software can be used to accumulate the statistics of EPFD for any proposed non-GSO system and then compare these statistics with the limits and time percentages in the Radio Regulations. DNR ITU-R BO.[Doc.11/136] provides a functional description of the BR software, including sections on testing, documentation, and verification of the software. One or more candidate software programs that comply with this specification should be available for BR to evaluate prior to WRC-2000 and selection of software to be used for EPFD compliance testing should be approved at WRC-2000.

3.1.5.1 Summary of specification for the software

DNR ITU-R BO.[Doc.11/136] provides the specification for the software which the BR/ITU would use to verify that a non-GSO network meets the $EPFD_{down}/EPFD_{up}/EPFD_{is}$ limits. This specification has been made available to administrations.

A software implementation that includes all the inputs, functions, and outputs described DNR ITU-R BO.[Doc. 11/136] would enable BR to check compliance of any non-GSO system with the EPFD limits. Input parameters include the following:

- reference parameters (earth station and space station reference antenna radiation patterns, etc.);
- inputs from the ApS4 supplied by the administration for the non-GSO system;
- GSO earth station location test points.

The block diagram of the software algorithm is shown in Figure 3-3. It consists of two sections: that of Initial Data and that of Calculation. The Initial Data Section contains the whole set of parameters relevant to the notified non-GSO satellite system, a set of reference GSO system parameters as well as $EPFD_{down}/EPFD_{up}/EPFD_{is}$ limits. The Calculation Section is designed for estimations required to examine notified non-GSO systems compliance with the $EPFD_{down}/EPFD_{up}/EPFD_{is}$ limits. The Calculation Section is based on a concept of a downlink pfd mask², an uplink e.i.r.p. mask³, and an inter-satellite pfd mask⁴.

A pfd/e.i.r.p. mask is calculated in Block 1 based on the notified non-GSO system parameters delivered from the Initial Data Section. Block 4 tests the aggregate interference produced by non-GSO network stations for meeting $EPFD_{down}/EPFD_{up}/EPFD_{is}$ limits. The verification in Block 4 is effected on the basis of the non-GSO system constellation characteristics from the Initial Data

² A pfd mask is the maximum pfd produced by a non-GSO space station.

³ An e.i.r.p. mask is the maximum e.i.r.p. radiated by a non-GSO earth station and is a function of the off-axis angle from the transmitting antenna main beam.

⁴ This is the maximum e.i.r.p. radiated by a non-GSO space station and is a function of the off-axis angle from the transmitting antenna main beam.

Section, a pfd/e.i.r.p. mask from Block 1 and output data from Block 3. The output data are verified for validity in Block 2.

Taking into account the significant complexity regarding specific features of different non-GSO system configurations in the software it would seem appropriate to impose some burden of responsibility relevant to testing for $EPFD_{down}/EPFD_{up}/EPFD_{is}$ limits on administrations notifying appropriate non-GSO systems. Therefore the examination procedure for meeting $EPFD_{down}/EPFD_{up}/EPFD_{is}$ limits would consist of two stages. The first stage would include the software development (Block 1) and conducting all the calculations by the administrations notifying non-GSO satellite systems. The stage would also include estimation of a mask for pfd/e.i.r.p. produced by interfering non-GSO network stations. The mask would account for all the features of specific non-GSO systems arrangements. The first stage would be finalized with delivering the pfd/e.i.r.p. mask in analytical or documented formats to the BR/ITU. Moreover the notifying administration would provide the BR/ITU with the software used in Block 1 for the pfd/e.i.r.p. mask estimation, the complete software description and parameters from Block "a": the information will also be available to other administrations.

The second stage calculations would be effected at the BR/ITU. The second stage would feature the following operations:

- 1) Definition of the maximum EPFD geometry of a GSO space station and an earth station of that network (Block 3). It would ensure verification of sharing feasibility for a notified non-GSO network with any GSO network in the FSS and BSS.
- 2) $EPFD_{down}/EPFD_{up}/EPFD_{is}$ statistics estimation (Block 4).
- 3) Software results verification for validity (Block 2).
- 4) Making a decision on interference compliance with $EPFD_{down}/EPFD_{up}/EPFD_{is}$ limits (Block 4).

The estimations are based on the non-GSO system parameters (Block "a") delivered by a notifying administration and the initial data (Block "b") available at the BR/ITU.

Any administration may use as required software that uses the algorithms defined in this document together with data on the non-GSO networks to estimate statistics for interference into its own GSO networks and check for compliance with $EPFD_{down}/EPFD_{up}/EPFD_{is}$ limits.

3.1.5.2 Software validation process

Several administrations and other organizations are understood to be developing such software.

The candidate software shall be tested for accuracy using the guidelines stated in Annex 1 of DNR ITU-R S.[Doc. 11/136]. The procedures given in DNR ITU-R S.[11/136] shall be used for the validation of the candidate software.

In order to allow sufficient time for the BR to evaluate the candidate software and prepare its report, administrations have been requested to supply the candidate software to the BR by mid-January 2000.

3.1.5.3 Further work required

Upgrading of the software would be necessary to take account of decisions of future radio conferences.

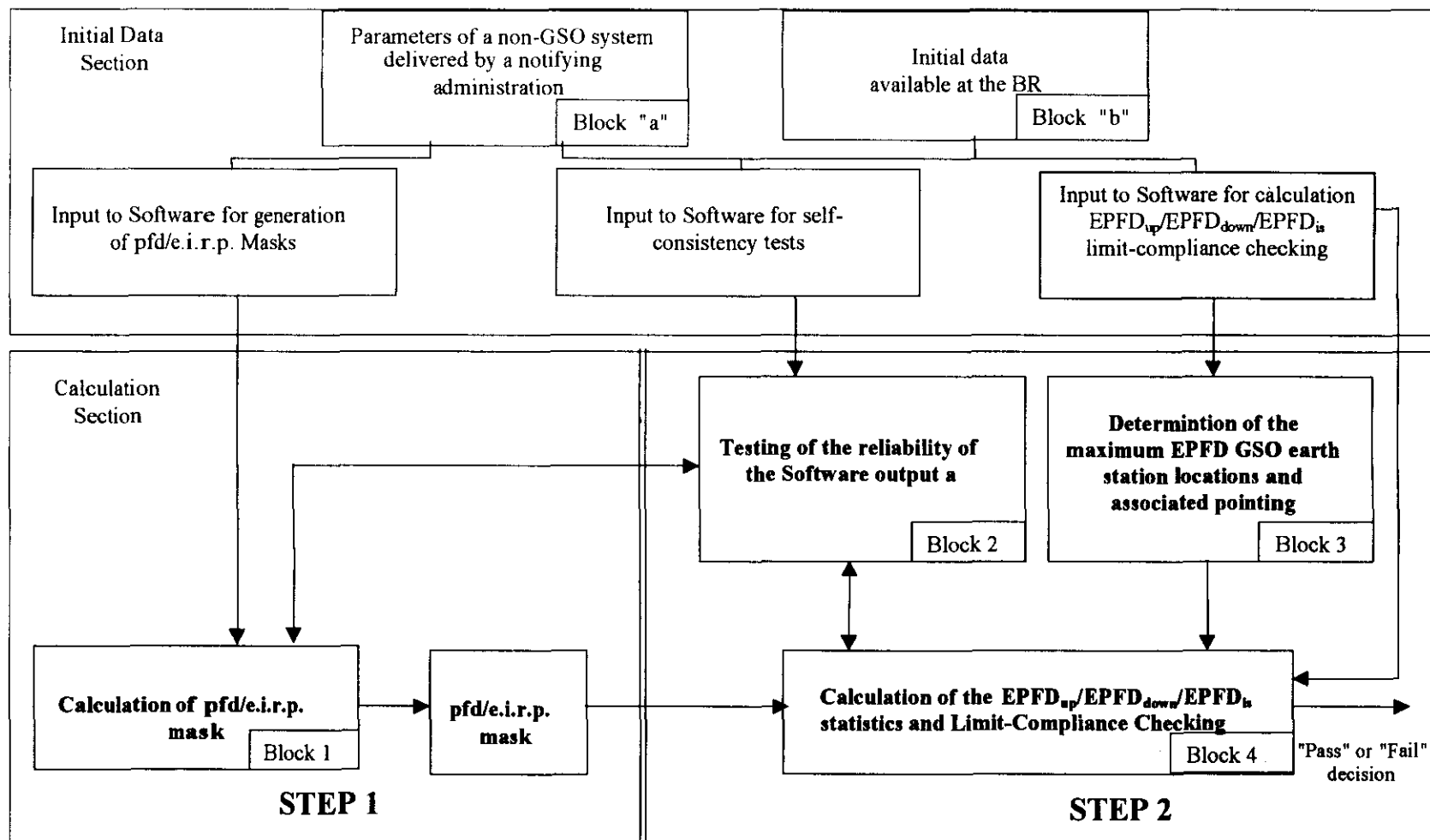


FIGURE 4-3

3.2 Agenda item 1.13.2

“to consider the inclusion in other frequency bands of similar limits in Articles S21 and S22, or other regulatory approaches to be applied in relation to sharing situations “

3.2.1 Sharing considerations between non-GSO FSS and GSO BSS receive earth stations in the 17.3 - 17.8 GHz band

Resolution 538 (WRC-97) introduced provisional EPFD and APFD EPFD_{up} limits for non-GSO FSS systems in certain bands intended to protect GSO BSS systems. Resolution 538 (WRC-97) did not designate use of the 17.3 - 17.8 GHz band in Region 2 by non-GSO FSS, stating that such use required further study as to the feasibility of non-GSO FSS to share with the allocated BSS service in this band. The ITU-R considered the sharing situations identified in Resolution 538 (WRC-97).

Regarding sharing between transmit GSO BSS space stations and receive non-GSO FSS space stations, it was concluded that there would be no need for specific provisions since the sharing situation would be similar to that existing between GSO FSS transmit space stations and non-GSO FSS receive space stations in the adjacent band 17.8 - 18.4 GHz.

Regarding the feasibility of sharing between transmitting non-GSO FSS earth stations and ubiquitous BSS receive earth stations in the 17.3 - 17.8 GHz band, it was noted that this situation would require coordination, using the existing provisions under S9.17A, between the administrations on the territories of which the non-GSO FSS transmitting earth stations and BSS receive earth stations are located. It was also noted that the frequency band 17.7 - 17.8 GHz is also allocated to the fixed-satellite service (space-to-Earth).

It was concluded that sharing is not feasible between ubiquitous non-GSO FSS user terminals and ubiquitous BSS receive terminals located in the same geographical region.

Regarding non-GSO gateway operation, the studies reported to the ITU-R concluded that the coordination distance with BSS receive terminals would be the default value of 100 km. This means that coordination would have to take place between administrations when the distance between a non-GSO gateway and the territory of another administration intending to deploy BSS receive terminals is smaller than 100 km. During this coordination the separation distances required to avoid unacceptable interference would be assessed.

One study determined the separation distance to be between 15.8 and 93.9 km for non-GSO FSS gateways for the particular system studied (F-SAT MULTI 1B).

It was based on:

- A steady state long-term protection criterion of -18 dB was assumed in this study. This value is consistent with the Recommendations established in the DNR on the protection of the BSS from non-GSO-FSS when the interfering source is not time varying. Given the unavailability of statistics on the time varying nature of the interference from non-GSO FSS gateway terminals, this was considered a reasonable assumption.
- A 2.5 metre non-GSO gateway antenna using a minimum 10 degree elevation angle.
- Use of both a worst-case and best-case relative azimuth angle between the source and victim antennas, bounding the time varying nature of the interference.
- A simple space loss propagation model.

Another study considered the same non-GSO FSS system (F-SAT MULTI 1B) and was based on:

- the statistical method included in the draft new Recommendation (Document 4/60) is being considered for possible inclusion in Appendix S7 to deal with non-GSO FSS earth station interference, and
- the I/N criterion of 8 dB not to be exceeded for more than 0.003% of the time provisionally agreed to by WP 10-11S at its last meeting for the protection of BSS in this particular sharing situation.

This study concluded that, for a 0° horizon elevation around a non-GSO FSS gateway, the separation distances for the gateways of this particular system are typically 20 km, ranging from 1 km to 45 km, depending on the azimuths considered around the gateway. It also showed that, for a 1° horizon elevation around the gateway in every direction (i.e. 20 metre horizon height at a 1 km distance), this separation distance would fall to 1 km in all directions.

It was agreed that these distances are in reasonable agreement, since the differences can be explained by the different assumptions and methods used.

It was also agreed that the BSS is dependent on the ability to deploy ubiquitous receive earth stations.

Views were expressed that, since the BSS is intended for general reception by the public, and consequently the geographical service area should not be limited or restricted, and given that the number of non-GSO FSS gateways proposed for this band would be large, as are the separation distances required, non-GSO FSS use of the 17.3 - 17.8 GHz band in Region 2 would not be feasible.

Several views were also expressed that, given that the number of non-GSO FSS gateways proposed in this band would not be large, and given the small separation distances shown in the second study, the use of non-GSO FSS gateway transmit earth stations in this band would be feasible without undue constraints on the development of GSO BSS.

3.2.2 Frequency band 17.3 - 17.8 GHz

It was recognized that there is currently an allocation to BSS in Region 2 in the frequency band 17.3 - 17.8 GHz, allocation entering into effect on 1 April 2007 (RR No. S5.517). If power limits were to be used for sharing between non-GSO BSS systems in Region 2 and GSO BSS feeder links, the single entry EPFD_{is} applicable to the frequency band 17.8 - 18.1 GHz (-160 dB(W/m²·40 kHz) would be appropriate in the frequency band 17.3 - 18.1 GHz.

3.2.3 18.1 - 18.4 GHz band

The ITU-R examined the possibility of applying EPFD_{up} limits in the band 18.1 - 18.4 GHz, intended to protect GSO BSS feeder links in this band from interference caused by non-GSO FSS systems operating in the Earth-to-space direction.

It was noted that the sharing and regulatory situations in the 17.8 - 18.1 GHz band and in the 18.1 - 18.4 GHz band currently differ only on the following aspects:

- In the 17.8 - 18.1 GHz band, sharing between BSS feeder links and non-GSO FSS (Earth-to-space) is effected by the EPFD_{up} limits which have been reviewed ITU-R.
- In the 18.1 - 18.4 GHz band, sharing between BSS feeder links and non-GSO FSS (Earth-to-space) is effected by the application of RR No. S22.2.

As RR No.S5.520 currently restricts the use of this band by FSS (Earth-to-space) to BSS feeder links, the use of this band by non-GSO FSS (Earth-to-space) other than BSS feeder links would therefore require a modification to this footnote.

It was also concluded that there would be a need to include EPFD_{up} limits in Article S22 to protect GSO BSS feeder links in this band, if WRC-2000 decides that this band may be used by non-GSO FSS Earth-to-space other than BSS feeder links. The level considered appropriate for these limits to protect GSO BSS feeder links is that proposed by in Annex 1 for the EPFD_{up} limits in the adjacent band (17.8 - 18.1 GHz) and for EPFD_{is} limits in the 18.1 - 18.4 GHz band.

The ITU-R also noted that no regulatory approaches other than the power limits approach were studied or proposed for this band.

Concerns were raised about the impact of coordination distances required between non-GSO FSS transmitting earth stations and receiving FSS earth stations on the ability to ubiquitously deploy receiving terminals in the FSS in this band. It was noted however, that the selection of either type of service in a particular country is a matter of national decisions. In the case of non-GSO FSS transmitting gateways, coexistence with other FSS receiving terminals in neighbouring countries could be ensured through bilateral coordination, when necessary.

With regard to the fixed service, studies have been undertaken to evaluate the interference from fixed service systems into non-GSO FSS space stations in the 18.1 - 18.4 GHz band, where the two services are allocated on a co-primary basis. The studies were based on the characteristics of typical FS point-to-point systems and on the characteristics of the space stations of the FSATMULTI-1B non-GSO FSS system. The study concluded that, even under pessimistic assumptions, the interference from FS systems into non-GSO FSS (Earth-to-space) in the 18.1 - 18.4 GHz frequency range would be acceptable. However, the ITU-R notes that studies on the potential interference to FS receiving stations from non-GSO FSS transmitters have not been completed.

3.2.4 Frequency outside of range 10 GHz - 30 GHz

When it adopted Resolution 130 and the provisional limits that would apply to non-GSO FSS systems in certain bands between 10 and 30 GHz, WRC-97 determined that for these specific bands, non-GSO systems in the FSS should bear more of the burden of accommodating sharing than should co-frequency GSO FSS systems. WRC-97 did not decide how to assign sharing burdens between GSO and non-GSO systems in any FSS bands above 30 GHz or below 10 GHz, but instead requested that the ITU-R "undertake the development of power limits or other frequency sharing mechanisms" - at least in such bands where non-GSO FSS systems are likely to be implemented and GSO systems are used or expected to be used extensively. This direction is consistent with section 4.3.7.2 of the CPM-97 Report, which recognized that a power limits approach of the type that is now reflected in Resolution 130 "is not suited for sharing situations where more burden would be placed on the GSO FSS systems or the burden would be equally shared between the GSO and non-GSO ... systems," and that the "establishment of e.i.r.p. and pfd limits may not be a suitable approach for all types of non-GSO ... networks in every FSS band."

There are fundamental differences between the situation in the 10 - 30 GHz FSS bands identified in Resolution 130 where a non-GSO FSS service concept is being overlaid upon an existing and/or imminent GSO FSS service and other bands where both GSO and non-GSO FSS systems are just now beginning to emerge. In these 10 - 30 GHz bands, there is extensive deployment or long-standing development of GSO systems and GSO operators have limited or no flexibility to adjust to the introduction of non-GSO systems. In these bands, non-GSO systems must thus bear most or all of the burden of implementing technical criteria to protect the GSO arc. In bands where there has been little or no deployment of satellite systems to date and satellite networks (GSO and non-GSO alike) have only recently begun to be communicated to ITU-R, the absence of current and imminent use by GSO and non-GSO FSS systems means that both types of operators should expect

to exhibit greater flexibility in achieving the appropriate balance among the competing technical, regulatory and policy considerations that will affect their sharing environment.

Technical studies of interference mitigation techniques that may be employed by non-GSO and/or GSO FSS operators in bands outside 10 - 30 GHz to enable co-frequency sharing are under way in ITU-R. Simulation results on a planned non-GSO FSS system in the 40 - 50 GHz band were provided, analysing the impact of two mitigation techniques. The first set of results assumed polarization discrimination between the GSO and the non-GSO systems. To use this mitigation technique, the non-GSO system has to be on the opposite polarization from every GSO system with which it will have in-line events. The second set of results assumes that the GSO satellite can also use satellite diversity as an interference mitigation technique. This technique would improve the GSO link availability and increase the system capacity because the propagation impairments at these frequency bands are severe. Both techniques proved to be efficient in mitigating the mainbeam-to-mainbeam interference that can appear between non-GSO and GSO systems operating co-frequency in these bands. However, both would constrain the GSO FSS to either use only one polarization or to double the number of satellites required.

Although the techniques examined in bands outside 10 - 30 GHz offer promise in mitigating the mainbeam-to-mainbeam interference that can appear between co-frequency non-GSO and GSO systems, further work needs to be done on these potential mitigation techniques and other approaches and refinements that have yet to be addressed within ITU-R. Matters that remain to be addressed in these bands include whether there would be coordination between non-GSO and GSO systems, the appropriateness of retaining RR No. S22.2, the impact of other co-frequency services in a particular band on the GSO/non-GSO sharing situation and the impact of any regulatory approach for GSO and non-GSO sharing on innovation in all services in a particular band.

As a result, ITU-R is not in a position to make a final recommendation on whether power limits on the non-GSO FSS operator or some other frequency sharing mechanism or combination of mechanisms should be imposed to facilitate GSO/non-GSO FSS sharing in any FSS band outside the 10 - 30 GHz range. There is no technical basis at this time for extending to FSS bands above 30 GHz and below 10 GHz either the regulatory scheme that is established in Resolution 130 for certain FSS bands between 10 and 30 GHz or any other regulatory/procedural approach (e.g. Resolution 46/RR S9.11A). The regulatory scheme in Resolutions 130 and 538 reflects the particular circumstances at 10 - 30 GHz and is inappropriate for application by default to the very different circumstances that exist in the FSS bands above 30 GHz and in certain of the FSS bands below 10 GHz.

3.2.5 Other regulatory approaches

A number of studies considered by ITU-R presented the per-satellite pfd approach as an approach to enable sharing between GSO and non-GSO FSS systems. However, there is concern that the current form of per-satellite pfd limits would unacceptably constrain the design flexibility of non-GSO FSS systems. Further study is required before this per-satellite pfd approach may be considered to be a viable regulatory option.

ANNEXES 1-4 TO CHAPTER 3

ANNEX 1 TO CHAPTER 3

Examples of possible modifications to Section II of Article S22

Section II – Control of interference to geostationary-satellite systems

NOC S22.2
to
S22.5A

Existing texts from **S22.5B to S22.5G** is proposed to be replaced by the provisions given in this Annex 1.

MOD S22.5B § 5 1) The equivalent power flux-density^{xx}, $EPFD_{down}$, at any point on the Earth's surface visible from the geostationary-satellite orbit, produced by emissions from all the space stations of a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table **S22-1**, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Table **S22-1** for the given percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Table **S22-1**, for all pointing directions towards the geostationary-satellite orbit.

xxMOD S22.5B.1

The equivalent power flux-density is defined as the sum of the power flux-densities produced at a GSO receive station on the Earth's surface or in the geostationary orbit, as appropriate, by all the transmit stations within a non-geostationary-satellite system, taking into account the off-axis discrimination of a reference receiving antenna assumed to be pointing its nominal direction. The equivalent power flux-density is calculated using the following formula:

$$epfd = 10 \cdot \log_{10} \left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_i(\theta_i)}{4 \cdot \pi \cdot d_i^2} \cdot \frac{G_r(\phi_i)}{G_{r,max}} \right]$$

where:

- N_a is the number of transmit stations in the non-geostationary-satellite system that are visible from the GSO receive station considered on the Earth's surface or in the geostationary orbit, as appropriate
- i is the index of the transmit station considered in the non-geostationary-satellite system
- P_i is the RF power at the input of the antenna of the transmit station, considered in the non-geostationary satellite system in dBW in the reference bandwidth
- θ_i is the off-axis angle between the boresight of the transmit station considered in the non-geostationary satellite system and the direction of the GSO receive station
- $G_i(\theta_i)$ is the transmit antenna gain (as a ratio) of the station considered in the non-geostationary satellite system in the direction of the GSO receive station
- d_i is the distance in metres between the transmit station considered in the non-geostationary satellite system and the GSO receive station
- ϕ_i is the off-axis angle between the boresight of the antenna of the GSO receive station and the direction of the i th transmit station considered in the non-geostationary satellite system
- $G_r(\phi_i)$ is the receive antenna gain (as a ratio) of the GSO receive station in the direction of the i th transmit station considered in the non-geostationary satellite system
- $G_{r,max}$ is the maximum gain (as a ratio) of the antenna of the GSO receive station
- $EPFD$ is the computed equivalent power flux-density in dB(W/m²) in the reference bandwidth

MOD TABLE S22-1⁵**Limits to the EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands**

Frequency band (GHz)	Equivalent pfd dB(W/m ²)	Percentage of time during which equivalent pfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern ²
10.7 - 11.7; 11.7 - 12.2 in Region 2; 12.2 - 12.5 in Region 3 and 12.5 - 12.75 in Regions 1 and 3	-175.4	0	40	60 cm Rec. S.[4/57]
	-174.0	90		
	-170.8	99		
	-165.3	99.73		
	-160.4	99.991		
	-160.0	99.997		
	-160.0	100		
	-181.9	0	40	1.2 m Rec. S.[4/57]
	-178.4	99.5		
	-173.4	99.74		
	-173.0	99.857		
	-164.0	99.954		
	-161.6	99.984		
	-161.4	99.991		
	-160.8	99.997		
	-160.5	99.997		
	-160.0	99.9993		
	-160.0	100		
	*		40	3 m Rec. S.[4/57]
	*		40	10 m Rec. S.[4/57]

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.* : No agreement could be reached on EPFD_{down} values for protection of the 3m and 10m GSO FSS antennas. See Section 3.1.4.1.4.2 (a) of the text.⁵ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

In addition to the FSS single-entry masks above, a second single-entry EPFD_{down} limit was identified

100% of the time EPFD_{down} dB(W/m²/40kHz)	Latitude (North or South) (°)
-160	0 < Latitude < 57.5
$-160 + 3.8(57.5 - \text{ABS}(\text{Latitude}))/5$	57.5 < Latitude < 62.5
TBD	62.5 < Latitude

MOD TABLE S22-1¹**Limits to the EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands**

Frequency Band (GHz)	EPFD_{down} dB(W/m²)	Percentage of time during which equivalent pfd may not be exceeded	Reference Bandwidth (kHz)	Reference antenna diameter, and reference pattern ²
17.8-18.6	-164	100	40 ³	1 m Rec. S.[4/57]
	-164	99.971		
	-167	99.714		
	-172.5	99		
	-175.4	90		
	-175.4	0		
17.8-18.6	-164	100	40 ³	2 m Rec. S.[4/57]
	-164	99.977		
	-166	99.971		
	-170.5	99.913		
	-171.4	99.9		
	-178.4	99.4		
17.8-18.6	-178.4	0	40 ³	5 m Rec. S.[4/57]
	-164	100		
	-164	99.998		
	-172	99.943		
	-180	99.943		
	-180	99.8		
	-185.4	99.8		
	-185.4	0		

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

³ For non-GSO emission bandwidths greater than 40 kHz, the EPFD_{down} limits may be scaled by adding $10 \log(\text{non-GSO emission bandwidth} / 40 \text{ kHz})$ in a reference bandwidth equal to the emission bandwidth.

MOD TABLE S22-1¹**Limits to the EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands**

Frequency Band (GHz)	EPFD_{down} dB(W/m²)	Percentage of time during which equivalent pfd may not be exceeded	Reference Bandwidth (kHz)	Reference antenna diameter, and reference pattern
19.7-20.2	-154 -154 -172 -182 -187.4	100 99.983 97.143 71.429 0	40 ³	70 cm Rec. S.[4/57]
19.7-20.2	-154 -154 -160 -165 -168.6 -170.4 -181.4 -190.4	100 99.997 99.943 99.943 99.8 99.8 91 0	40 ³	90 cm Rec. S.[4/57]
19.7-20.2	-154.35 -154.35 -196.4	100 99.9971 0	40 ³	2.5 m Rec. S.[4/57] see note 4
19.7-20.2	-154.35 -154.35 -163.5 -175 -184 -189 -189.4 -195 -200.4	100 99.999 99.99 99.886 97.143 92 90 66 0	40 ³	5 m Rec. S.[4/57] see note 4

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

³ For non-GSO emission bandwidths greater than 40 kHz, the EPFD_{down} limits may be scaled by adding $10 \log(\text{non-GSO emission bandwidth} / 40 \text{ kHz})$ in a reference bandwidth equal to the emission bandwidth.

⁴ The masks for the 2.5m and 5m antennas have not been agreed. Further adjustments to these masks are required.

MOD TABLE S22-1¹

**Limits to the EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands
30cm, 45cm and 60cm BSS antennas**

Frequency band (GHz)	Equivalent pfd dB(W/m²)	Percentage of time during which equivalent pfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern ²
11.7 – 12.5 GHz In Region 1 11.7 – 12.2 GHz and 12.5 – 12.75 GHz In Region 3 12.2 – 12.7 GHz In Region 2	-165.841 -165.541 -164.041 -158.600 -158.600 -158.330 -158.330	0.000 25.000 96.000 98.857 99.429 99.429 100.000	40	30 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.5 GHz In Region 1 11.7 – 12.2 GHz and 12.5 – 12.75 GHz In Region 3 12.2 – 12.7 GHz In Region 2	-175.441 -172.441 -169.441 -164.000 -160.750 -160.000 -159.900	0.000 66.000 97.750 99.357 99.809 99.986 100.000	40	45 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.5 GHz In Region 1 11.7 – 12.2 GHz and 12.5 – 12.75 GHz In Region 3 12.2 – 12.7 GHz In Region 2	-176.441 -173.191 -167.750 -162.000 -161.000 -160.200 -160.000 -159.900	0.000 97.800 99.371 99.886 99.943 99.971 99.997 100.000	40	60 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

MOD TABLE S22-1¹**Limits to the EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands****90cm and 120cm BSS antennas**

Frequency band (GHz)	Equivalent pfd dB(W/m²)	Percentage of time during which equivalent pfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern ²
11.7 – 12.5 GHz In Region 1	-178.94 -178.44 -176.44	0.000 33.000 98.000	40	90 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-171.00	99.429		
12.5 – 12.75 GHz	-165.50	99.714		
In Region 3	-163.00	99.857		
12.2 – 12.7 GHz	-161.00	99.943		
In Region 2	-160.00	99.991		
	-159.90	100.000		
11.7 – 12.5 GHz In Region 1	-182.440 -180.690 -179.190 -178.440	0.000 90.000 98.900 98.900	40	120 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-174.940 -173.750	99.500 99.680		
12.5 – 12.75 GHz	-173.000	99.680		
In Region 3	-169.500	99.850		
12.2 – 12.7 GHz	-167.800	99.915		
In Region 2	-164.000	99.940		
	-161.900	99.970		
	-161.000	99.990		
	-160.400	99.998		
	-159.900	100		

¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

MOD TABLE S22-1¹**Limits to the EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands****180cm (*), 240cm (*) and 300cm(*) BSS antennas**

Frequency band (GHz)	Equivalent pfd dB(W/m²)	Percentage of time during which equivalent pfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern ²
11.7 – 12.5 GHz In Region 1 11.7 – 12.2 GHz and 12.5 – 12.75 GHz In Region 3 12.2 – 12.7 GHz In Region 2	-184.941 -184.101 -181.691 -176.250 -163.250 -161.500 -160.350 -160.000 -159.900	0.000 33.000 98.500 99.571 99.946 99.974 99.993 99.999 100.000	40	180 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.5 GHz In Region 1 11.7 – 12.2 GHz and 12.5 – 12.75 GHz In Region 3 12.2 – 12.7 GHz In Region 2	-187.441 -186.341 -183.441 -178.000 -164.400 -161.900 -160.500 -160.000 -159.900	0.000 33.000 99.250 99.786 99.957 99.983 99.994 99.999 100.000	40	240 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.5 GHz In Region 1 11.7 – 12.2 GHz and 12.5 – 12.75 GHz In Region 3 12.2 – 12.7 GHz In Region 2	-191.941 -189.441 -185.941 -180.500 -173.000 -167.000 -162.000 -160.000 -159.900	0.000 33.000 99.500 99.857 99.914 99.951 99.983 99.991 100.000	40	300 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]

- ¹ For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.
- ² Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.
- (*) Not agreed (see Section 3.1.3.1.4(b)). Although for antenna diameters 180 cm, 240 cm and 300 cm agreement has not been reached provisional masks have been presented. Some administrations wish to perform further studies of these masks. Further results may be available to the CPM.

NOTE - For checking compliance with these limits, the BR software will use increments of 0.1 dB and will test against the fractionally more severe value: for example where the EPFD_{down} limit is -165.841 dB(W/m²/40 kHz) the software will test against a criterion of -165.9 dB(W/m²/40 kHz).

Studies are continuing in order to avoid unnecessary entries in this Table and in order to provide maximum protection for the GSO FSS and GSO BSS.

In addition to the single entry masks shown above for BSS antenna diameters 180 cm, 240 cm and 300 cm a second single entry EPFD_{down} limit was identified:

99.999% of the time EPFD _{down} dB(W/m ² /40 kHz)	Latitude (North or South) (°)
-160	0 ≤ latitude ≤ 57.5
-160 + 3.8 *(57.5 – latitude)/5	57.5 ≤ latitude ≤ 62.5
-163.8	62.5 ≤ latitude

MOD S22.5C

2) The equivalent power flux-density^{xx}, EPFD_{up}, produced at any point in the geostationary-satellite orbit by emissions from all the earth stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table S22-2, for all conditions and for all methods of modulation, shall not exceed the limits given in Table S22-2 for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Table S22-2, for all pointing directions towards the Earth's surface visible from the geostationary-satellite orbit.

MOD TABLE S22-2**Limits to the EPFD_{up} radiated by non-GSO FSS systems in certain frequency bands**

Frequency band (GHz)	EPFD _{up} dB(W/m ²)	Percentage of time EPFD _{up} level may not be exceeded	Reference bandwidth (kHz)	Reference antenna beamwidth and reference radiation pattern ²
12.50 - 12.75 12.75 - 13.25 13.75 - 14.5	-160	100	40	4 degrees ITU-R S.672, Ls = -20 ¹
*	-160	100	40	4 degrees ITU-R S.672, Ls = -20 ¹
27.5 - 28.6	-162	100	40	1.55 degrees ITU-R S.672, Ls = -10 ¹
29.5 - 30.0	-162	100	40	1.55 degrees ITU-R S.672, Ls = -10 ¹

¹ For the case of Ls=-10, the values a=1.83 and b=6.32 should be used in the equations in Annex 1 of Recommendation ITU-R S.672 for single-feed circular beams. In all cases of Ls, the parabolic main beam equation should start at zero.

* This EPFD_{up} limit applies to the bands 17.3 - 18.1 GHz (Regions 1 and 3) and 17.8 - 18.1 GHz (Region 2). It is proposed that, even though there is currently no allocation to non-GSO FSS, the above-mentioned limit be also applicable to the frequency band 17.3 - 17.8 GHz (Region 2), in order to protect BSS feeder links in Region 2 from non-GSO FSS uplinks in Regions 1 and 3.

² Under this Section, this reference pattern is to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS systems.

MOD S22.5D

3) The equivalent power flux-density^{xx}, EPFD_{is}, produced at any point in the geostationary-satellite orbit by emissions from all the space stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table S22-3, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Table S22-3 for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions into a reference antenna and in the reference bandwidth specified in Table S22-3, for all pointing directions towards the Earth's surface visible from the geostationary-satellite orbit.

MOD TABLE S22-3

Limits to the EPFD_{is} radiated by non-GSO FSS systems in certain frequency bands

Frequency band (GHz)	EPFD _{is} dB(W/m ²)	Percentage of time EPFD _{is} level may not be exceeded	Reference bandwidth (kHz)	Reference antenna beamwidth and reference radiation pattern ¹
10.7 - 11.7 (Region 1) 12.5 - 12.75 (Region 1) 12.7 - 12.75 (Region 2)	-160	100	40	4 degrees ITU-R S.672, Ls = -20
17.8 - 18.4	-160	100	40	4 degrees ITU-R S.672, Ls = -20

¹ Under this Section, this reference pattern is to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS systems.

MOD S22.5E

The limits given in Tables S22-1 may be exceeded on the territory of any country whose administration has so agreed.

Reasons: Consequential.

ADD S22.5F

The limits specified in No S22.5B to S22.5D apply to non-GSO FSS systems for which complete notification information has been received after 22 November 1997.

Reasons: Reflect the "*instructs the Radiocommunication Bureau*" in Resolutions 130 (WRC-97) and 538 (WRC-97), and *resolves* 2 of Resolution 130 (WRC-97). Review of the findings by the Bureau under "*instructs the Radiocommunication Bureau*" in Resolution 130 (WRC-97) and Resolution 538 (WRC-97) should be kept in an updated version of these resolutions to cover transitional aspects. It was noted that no notification was received prior to 22 November 1997 for non-GSO FSS systems (Earth-to-space) in the bands 17.3 - 18.1 GHz (Regions 1 and 3) and 17.8 - 18.1 GHz (Region 2).

ADD S22.5G

An administration operating a non-GSO FSS system which is in compliance with the limits in No. **S22.5B** to **S22.5D** (see also Resolution WWW) shall be considered as having fulfilled its obligations under No. **S22.2** with respect to any GSO network, irrespective of the dates of receipt by the Bureau of the complete notification information for the non-GSO system and of the complete coordination information for the GSO network, provided that the EPFD_{down} radiated by the non-GSO FSS system into any operating GSO FSS earth station does not exceed the operational limits given in Table **S22-4**, when the gain of this earth station exceeds the corresponding value given in Table **S22-4** and the orbital inclination of the GSO FSS satellite does not exceed the corresponding value in Table **S22-4**.

Reasons: reflect the "resolves" 4 and 1.4 of Resolutions 130 (WRC-97) and 538 (WRC-97), and the principles provided in Section 3.1.2.1.4.2 c).

MOD TABLE S22-4¹

Operational Limits to the EPFD_{down} radiated by non-GSO FSS systems in certain frequency bands

Frequency Band (GHz)	EPFD _{down} dB(W/m ²)	Percentage of time during which equivalent pfd may not be exceeded	Reference Bandwidth (kHz)	Receive GSO earth station antenna Gain (dBi)	Orbital inclination of GSO satellite
10.7 - 12.75 GHz	-163	100	40	≥59	≤2.5°
	[-160]	100	40	≥59	≤4.5°
19.7 - 20.2 GHz	-157	100	40	≥55	[≤2.5]
	-157	100	40	≥43 ¹	[≤2.5]
	TBD	100	40	≥TBD	[≤4.5]
17.8 - 18.6 GHz	TBD	100	40	≥TBD	[>2.5 and ≤4.5]

¹The operational limit applies to non-GSO systems operating at altitudes of 7000 km or above in order to protect GSO FSS systems employing adaptive coding.

ADD S22.5H

In case of *force majeure*, telecommand and ranging carriers transmitted to non-geostationary satellites in the fixed-satellite service are not subject to the limits given in Table **S22-2**.

Reasons: Specific provision needed to cover emergency situations.

ANNEX 2 TO CHAPTER 3

EXAMPLE RESOLUTION WWW (WRC-2000)

**PROTECTION OF GSO FSS AND GSO BSS NETWORKS FROM THE MAXIMUM
AGGREGATE EQUIVALENT POWER FLUX-DENSITY PRODUCED BY MULTIPLE
NON-GSO FSS SYSTEMS IN FREQUENCY BANDS WHERE
EPFD LIMITS HAVE BEEN ADOPTED**

The World Radiocommunication Conference (WRC-2000, Istanbul),

considering

- a) that WRC-97 has adopted, in Article S22, provisional EPFD limits to be met by non-GSO FSS systems in order to protect GSO FSS and GSO BSS networks in parts of the frequency range 10.7 - 30 GHz;
- b) that WRC-2000 has revised these limits to ensure that they provide adequate protection to GSO systems without causing undue constraints to any of the systems and services sharing these frequency bands;
- c) that Article S22 includes single entry EPFD limits which apply to non-GSO FSS systems in these bands;
- d) that these single-entry limits have been derived from aggregate equivalent power flux-density (EPFD) masks that are intended to protect GSO networks, assuming a maximum effective number of non-GSO FSS systems of 3.5;
- e) that the aggregate interference caused by all co-frequency non-GSO FSS systems in these bands into GSO FSS systems should not exceed the maximum interference levels that are necessary to protect these GSO systems;
- f) that WRC-97 decided, and WRC-2000 confirmed, that non-GSO FSS systems in these bands are to coordinate the use of these frequencies between themselves under the provisions of No. S9.12 of the Radio Regulations;
- g) that the orbital characteristics of such systems are likely to be inhomogeneous;
- h) that as a result of this likely inhomogeneity, the aggregate EPFD levels from multiple non-GSO FSS systems are not directly related to the number of actual systems sharing a frequency band, and the number of such systems operating co-frequency is likely to be small,

recognizing

- a) that non-GSO FSS systems are likely to need to implement interference mitigation techniques to share frequencies among themselves;
- b) that because the use of such interference mitigation techniques will likely keep the number of non-GSO systems small, the aggregate interference caused by non-GSO FSS systems into GSO systems will also likely be small;
- c) that notwithstanding *considering* d), there may be instances where the aggregate interference from non-GSO systems could exceed the interference levels given in Annex 1;